AE

(12) UK Patent Application (19) GB (11) 2 226 310 (13) A

(43) Date of A publication 27.06.1990

(21) Application No 8830042.1

(22) Date of filing 23.12.1988

(71) Applicant
STC PLC

(Incorporated in the United Kingdom)

10 Maltravers Street, London, WC2R 3HA, United Kingdom

(72) Inventor
Roger Stephen Preston

(74) Agent and/or Address for Service
M C Dennis
STC Patents, West Road, Harlow, Essex, CM20 2SH, United Kingdom

(51) INT CL[5]
C03B 37/02

(52) UK CL (Edition K)
C1M M400 M401
G2J JGBC1

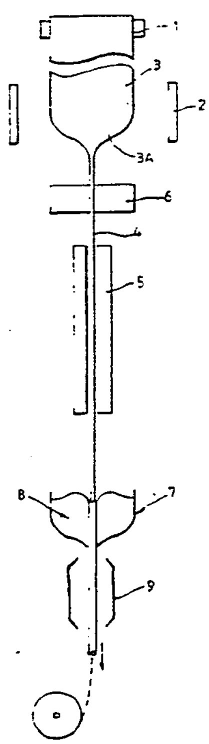
(56) Documents cited
GB 1377088 A US 4514205 A

(58) Field of search
UK CL (Edition J) C1M
INT CL[4] C03B

(54) **Optical fibre manufacture**

(57) An optical fibre (4) which has been freshly drawn is cooled by passing it down a long narrow cooling tube (5) and introducing helium gas at the top of the tube, the diameter of the tube being small so that the fibre draws the buoyant cooling gas from the top to the bottom of the tube as the gas transfers the heat from the fibre to the tube.

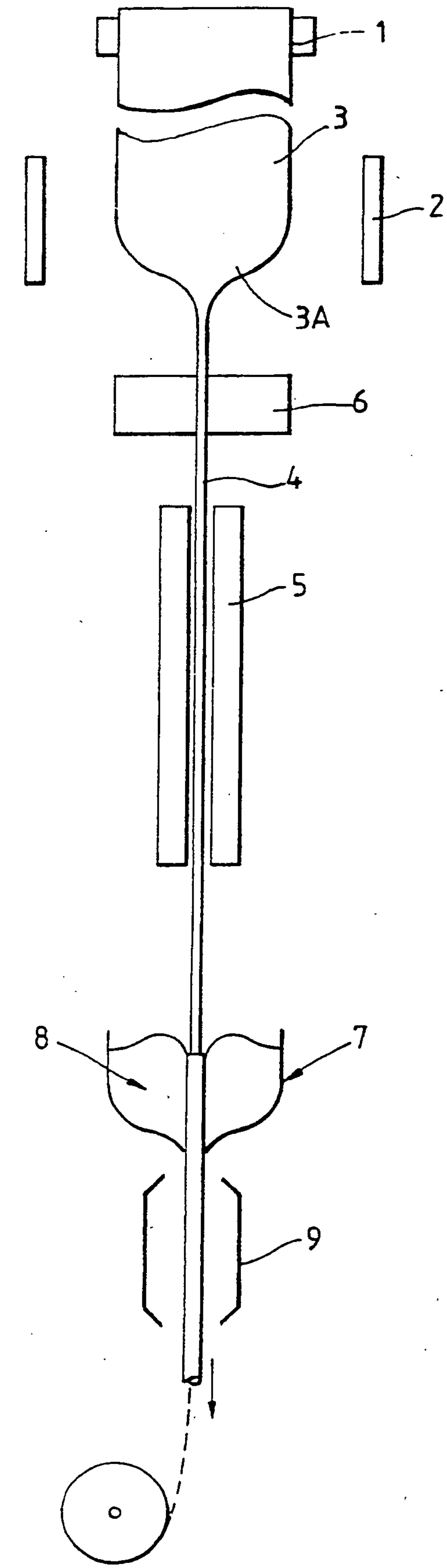
Fig.1.



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

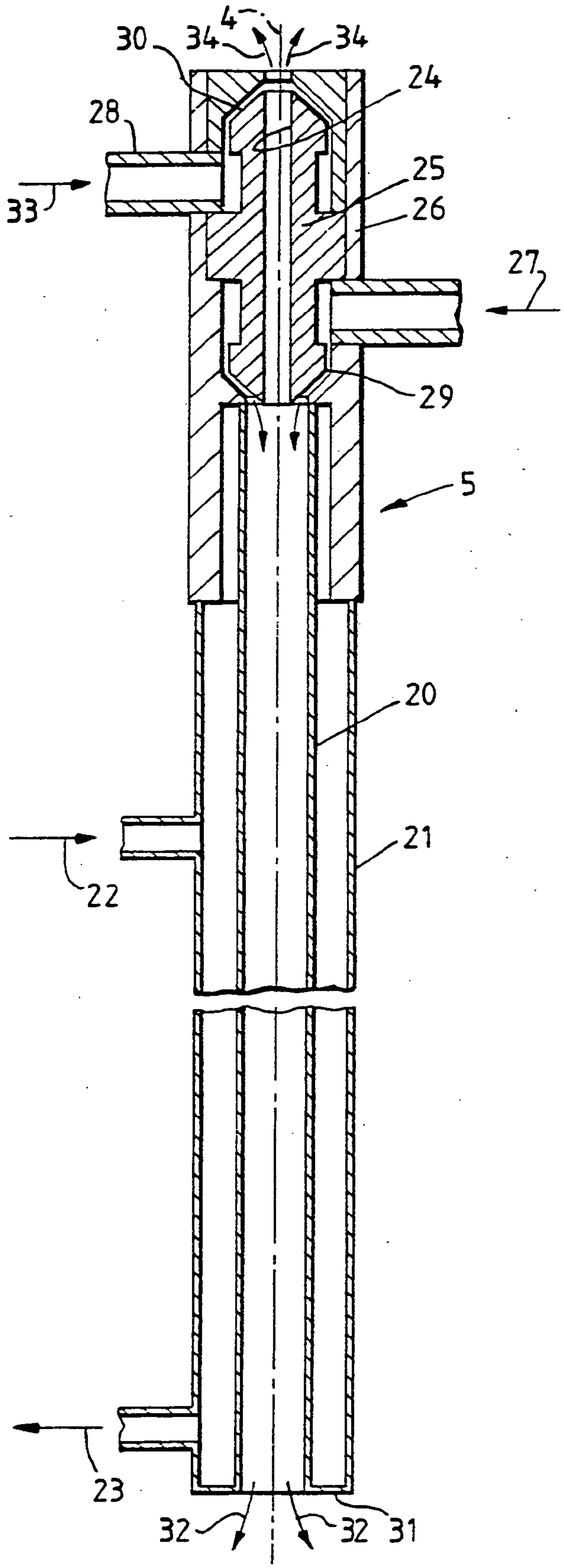
GB 2 226 310 A

Fig.1.



2/2

Fig.2.



OPTICAL FIBRE MANUFACTURE.

This invention relates to manufacturing optical fibre.

In order to reduce the production costs of optical fibres it is attractive to increase the speed of production provided the optical properties of the fibre so produced is not compromised.

Optical fibres need a protective layer normally applied as a liquid and then cured. Before the application of the protective layer the fibre temperature has to be reduced from that of the melt, approximately 1900°C, to a low enough temperature to prevent the protective layer being degraded by the still hot fibre.

As the fibre is drawn faster, the time within which the fibre can be cooled is clearly reduced at an inversely proportional rate. Forced cooling of the fibre can enable high drawing rates but it is difficult not to introduce vibration of the fibre which can cause problems.

The length over which cooling takes place can of course be increased but once again it is difficult to prevent fibre vibrations over such a long distance.

European patent application EP 0174699A1 discloses a method of cooling an optical fibre by using concealed water-cooling in a gas with good heat comducting properties. This patent specification discloses a cooling

tube surrounded by a water jacket and in which helium gas is introduced at the lower end of the tube and rises owing to its buoyancy in air up the inside of the cooling tube and transfers heat from the fibre to the cooling tube as the fibre passes in the opposite direction to the helium, through the tube.

Despite enabling an increased drawing speed to be achieved there is nevertheless only a modest improvement and this system is very wasteful of helium which is an expensive gas.

It is an object of the present invention to provide an improved manufacturing process for optical fibres and in particular to enable an increased drawing speed by improving the cooling of the fibre.

According to the present invention there is provided a method of manufacturing an optical fibre comprising drawing the fibre from a hot zone, cooling the fibre and treating the fibre on line with the drawing after cooling, wherein cooling the fibre is accomplished by passing the fibre through a cooling tube and introducing a heat-transfer cooling gas into the tube at or near the top thereof, the diameter of the tube and the speed of drawing being such that the fibre will pull the gas from the top of the tube to the bottom thereof while the gas transfers the heat from the fibre to the cooling tube.

According to another aspect of the present invention there is provided apparatus for manufacturing an optical fibre comprising means for drawing an optical fibre, means for cooling the fibre and means for treating the fibre after it has been cooled, said means for cooling the fibre comprising a narrow cooling tube surrounding the axis along which the fibre is drawn from the hot zone, and a gas entry port at or from near the top of the tube for

introducing cooling gas into the tube, whereby in use the fibre will pull the gas by friction from the top of the tube to the bottom thereof while the gas transfers the heat from the fibre to the cooling tube.

In order that the invention can be clearly understood reference will now be made to the accompanying drawings in which:-

Fig. 1 is a schematic drawing of a fibre pulling tower according to an embodiment of the present invention.

Fig. 2 shows in detail the cooling arrangement of Fig. 1.

Referring to Fig. 1 of the drawings the fibre pulling tower comprises a preform chuck 1 holding a glass preform 2 and advancing it into a furnace 3 to progressively melt the tip 3A.

An optical fibre 4 is drawn from the molten tip 3A through a fibre diameter monitor 6 and thence through a cooler 5 shown in cross section in greater detail in Fig. 2.

The fibre is then coated by passing it through a reservoir 7 of organic material 8. Organic liquids which are UV-curable (e.g. acrylated resins such as epoxy acrylates and urethane acrylates) or thermally curable (e.g. silicones) can be employed. The purpose is to maintain the integrity of the pristine surface of the drawn fibre, so as to maintain the strength of the fibre by minimising the possibility of surface flaws. Such coatings thus complete the surface coating conveniently by irradiation or by heating as the fibre passes through curing station 9.

The pulling tower has other refinements such as a coating concentricity monitor beneath the coating chamber and computer control such as is disclosed in our British Patent Application 2,179,339 A.

Referring now to Fig. 2, the fibre cooler is shown in longitudinal cross section and comprises a narrow

heat-conductive tube 20 which has an internal diameter of about 7mm and in this embodiment is made of a good heat conducting metal such as copper.

This tube is surrounded by a water-cooling jacket 21 having a cold-water inlet 22 and a water outlet 23, so the tube 20 is kept cool in use of the cooler.

The optical fibre 4 which has just been freshly drawn as shown in Fig. 1 enters the cooler 5 through the central bore 24 of a ferrule 25. The ferrule 25 is surrounded by a gas transfer jacket 26 which has a first gas supply port 27 and a second separate port 28.

The ferrule and jacket define first and second gas transfer passages 29 and 30. The passages 29 direct cooling gas into the top of the tube 20 from entrance port 27. The preferred gas is helium which is lighter than air and has a good heat conductivity, about seven times that of air.

The fibre 4 is drawn at a rate of about 3-4 m/sec and there exists about a four-metre gap between the furnace 2 and the coating application stage 7. The coating needs to be applied to the freshly-drawn fibre at around room temperature and it leaves the furnace at about 1900 Deg.C. The job of the cooler is to cool the fibre from this high temperature to room temperature within the distance mentioned, to e.g. 17 Deg.C.

We have found that by making the diameter of tube 20 small, i.e. smaller than about 15mm internal diameter, and by introducing the cooling gas at the top of the tube, we can effectively cool the fibre over a relatively short distance of about one and a half metres. The gas being lighter than air naturally would tend to stay at the top of the tube 20, but with fibre drawing speeds in excess of about 1.5 metres per second coupled with the narrowness of the tube, the frictional effect of the moving fibre is sufficient to pull the helium down the tube 20 and out at the bottom 31 as indicated by arrows 32.

In this way the heat transfer rate from the

moving fibre to the cooling water via the helium and the tube 20 is optimised.

Even if the gas was not as light as helium and even heavier than air, the advantages of introducing the gas at the top still prevail.

As the fibre enters the ferrule bore 24, entrained with it is a 'skin' of moving warm air. It is preferable to strip this from the fibre before it enters the cooler 5 and for this purpose the outlet passages 30 are directed at an angle towards the surface of the incoming fibre and against the direction of movements of the fibre and air is blown into entrance port 28 to achieve this, as indicated by arrows 33 and 34.

Because the tube 20 has a small bore it is important not only to ensure accurate concentric alignment of the tube around the fibre path, but also that the tube 20 is perfectly straight and not bowed. The fibre should not touch the side of the tube during transit therethrough.

Although in the preferred embodiment cooling to about 17^{o}C is contemplated, it is to be understood that at higher fibre drawing rates sub-zero cooling could be used. For example the cooling gas could be liquid nitrogen and there could be an anti-freeze cooling liquid in the cooling jacket. Some form of drainage for condensed water may be provided. So the cooling gas under these circumstances would be introduced from say a bubbler at a temperature (sub-zero) substantially below the temperature, e.g. room temperature, to which the fibre is cooled.

CLAIMS

1. A method of manufacturing an optical fibre comprising drawing the fibre from a hot zone, cooling the fibre and treating the fibre on line with the drawing after cooling, wherein cooling the fibre is accomplished by passing the fibre through a cooling tube and introducing a heat-transfer cooling gas into the tube at or near the top thereof, the diameter of the tube and the speed of drawing being such that the fibre will pull the gas from the top of the tube to the bottom thereof while the gas transfers the heat from the fibre to the cooling tube.

2. A method as claimed in claim 1 wherein the cooling gas is lighter than air.

3. A method as claimed in claim 2 wherein the cooling gas is mostly if not all, helium.

4. A method as claimed in any preceding claim wherein the diameter of the tube lies in the range 5mm to 15mm.

5. A method as claimed in any preceding claim, wherein the fibre is cooled to 20 Deg. C or less prior to coating the fibre.

6. A method as claimed in any preceding claim, wherein the cooling gas is introduced substantially colder than the temperature to which the fibre is cooled.

7. A method of manufacturing an optical fibre substantially as hereinbefore described with reference to the accompanying drawings.

8. Apparatus for manufacturing an optical fibre comprising means for drawing an optical fibre, means for cooling the fibre and means for treating the fibre after it has been cooled, said means for coating the fibre comprising a long narrow cooling tube surrounding the axis along which the fibre is drawn from the hot zone, and a gas entry port from near the top of the tube for introducing cooling gas into the tube, whereby in use the

fibre will pull the gas from the top of the tube to the bottom thereof while the gas transfers the heat from the fibre to the cooling tube.

9. Apparatus for manufacturing an optical fibre, substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.